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Understanding Bonding Coordinates and Physical Die Size

MAXIM High-Frequency/Fiber Communications Group

Maxim Integrated Products

Understanding Bonding Coordinates and Physical Die Size

1 Introduction

When calculating pad coordinates, there is often confusion between the die size specified in the data sheet and the physical die size after it is cut from the wafer. Although the physical die size is not needed for wire-bonding purposes, it's important to understand the difference between the two measurements and the tolerances that affect the overall physical die size. The physical edge of the die is not a good reference for wire bonding because of slight inconsistencies of overall die dimensions. In the discussion that follows, proper methods for die orientation and bonding coordinates will be explained, along with how to calculate the physical die size. The MAX3970 will be used as an example.

2 Bonding Conventions

Wire bonding does not require exact physical die dimensions for wire placement. Bonding pads on the die are oriented to a common reference point. Once a reference point is located, the remaining points are inferred easily. The following procedure is used to orient and define pad locations for Maxim fiber products:

1. Orient the die.
2. Define an origin.
3. Reference all other pads to the origin.

Locate the die identification number and align it with the diagram in its respective data sheet to orient dice. The die identification number generally begins with a HD, HF, or HT for Maxim Fiber Communication ICs. Once the die number is aligned, assign sides A, B, C, and D and identify the index pad (Figure 1). The index pad is defined as the bottom pad on side A.

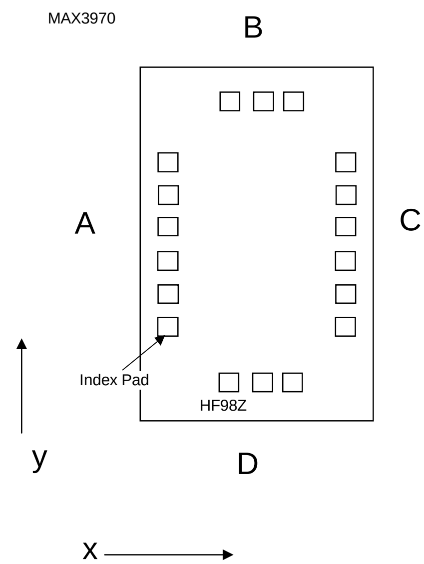

Figure 1. Die orientation

The origin is defined as the lower left visible corner of the index pad (Figure 2). The x-axis is defined as being parallel to side D, and the y-axis parallel to side A (Figure 2). Each pad is then referenced to its center from this origin. Bonding coordinates are available for all Maxim fiber parts sold as die.

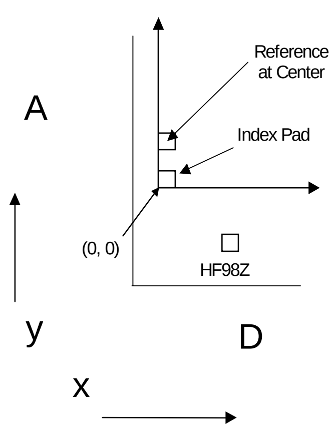

Figure 2. Die reference origin

Pad geometry varies from process to process. The bonding area is the section of the pad that is available for bonding (metal not covered by glass). Figures 3 and 4 illustrate how the origin is defined for square and octagonal pads.* Table 1 lists definitions of general wafer and pad parameters used in the bonding process.

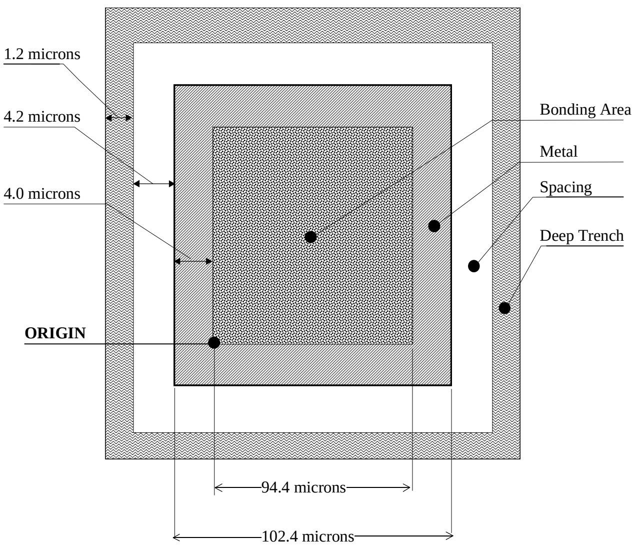

Figure 3. Square bond pad

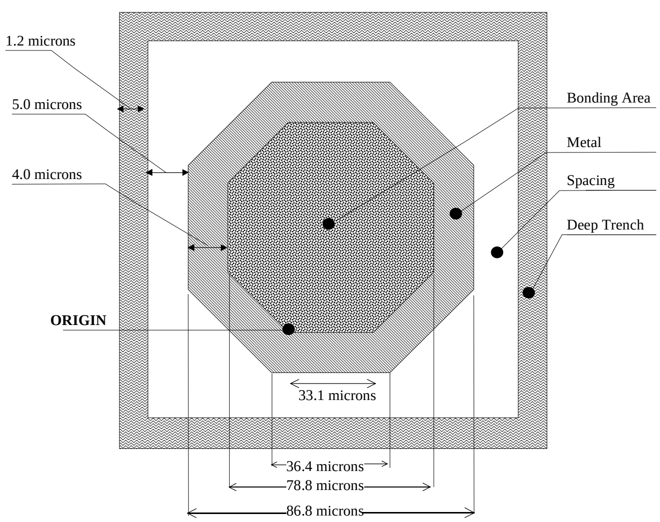

Figure 4. Octagonal bond pad

* Pad-dimension variables are process-related. The dimensions given in Figures 3 and 4 relate to the F60 process.

Table 1 Definitions of Wafer and Pad Parameters

PARAMETER	DEFINITION
Transistor Count	The number of active devices contained on the die. Historically, this information is used by the military in reliability calculations.
Substrate	Potentialed base silicon. The substrate is the physical material on which an integrated circuit is fabricated. Its primary function is mechanical support, but it may also serve other electrical functions.
Process	The technology used to fabricate semiconductor devices.
Glass Passivation	The protective glass layer that covers the die.
Bond Pad Size	The glass-free bondable area (passivation opening) on the die used for wire bonding.
Metalization	The application of metal alloy to the die. Metalization facilitates electrical conductivity.
Die Thickness	Wafer thickness after the thinning process. Typically wafers are thinned to 14mils.
Size	Center scribe to center scribe die dimension.
Bond Force	Range of acceptable bonding force.
Ultrasonic Power	Power used in ultrasonic pulse.
Bond Temperature	Range of acceptable bonding temperature.
Bond Time	Duration that bonding parameters must be applied.

3 Overall Die Dimensions (Physical vs. Published)

In order to specify the overall die size, additional parameters relevant to the die size must be specified. These are *die seal, scribe street, center scribe,* and *saw kerf,* explained below.

- **Die Seal: A peripheral line defining the boundary of the passivation layer on the die**

The die seal prevents cracks formed during the cutting from penetrating into active circuitry. The distance from the die seal to active circuitry must be at least 1mil (25.4microns). This is not always the distance to the edge of a pad, as there can be active circuitry that extends beyond the pads.

- **Scribe Street: An opening between die**

The scribe streets separate adjacent die and are arranged in a uniform pattern over the entire wafer. Horizontal and vertical scribe streets are not always identical in width. Scribe streets can vary from 3mils to 7mils (101.6microns to 177.8microns), depending on the process used.

- **Center Scribe: Center of the scribe street**

Defines the precut die dimensions. This is the die dimension given in Maxim fiber data sheets.

- **Saw Kerf: The amount of wafer that is removed when the blade cuts the die**

It can be thought of as the width of the blade but is actually determined by many other variables. Table 2 lists typical saw-kerf values. These values take into account other factors, such as chipping and drift.

Table 2 Typical Saw-Kerf Values

Saw Kerf	Wafer Thickness
2.5 – 3.0 mil	<15 mil
3.0 – 3.5 mil	15 – 20 mil
4.0 – 4.5 mil	>20 mil

Figure 5 shows the orientation of the die seal, scribe street, center scribe, and saw kerf. The dimensions from center scribe to center scribe are the published die dimensions found in Maxim fiber data sheets. Actual physical dimensions vary due to manufacturing tolerances and saw kerf. Absolute maximum and minimum physical die size can vary as much as the scribe-street width, but this is not typical. The next section explains how to calculate typical die sizes

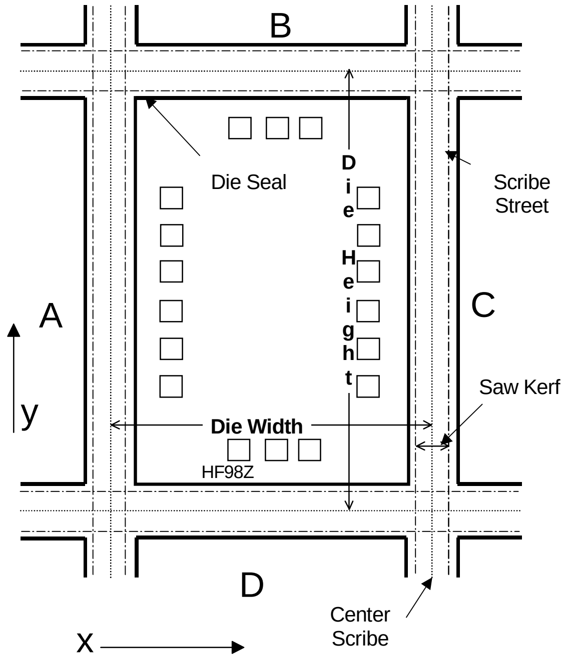

Figure 5. Die terminology

4 Example: Die-Size Calculation (MAX3970)

The MAX3970 measures 34mils by 53mils from center scribe to center scribe. This is the die-size measurement published in the data sheet. The horizontal and vertical scribe streets for the MAX3970 are 5mils wide. The wafer is < 15mils thick. Table 2 assigns a saw kerf of 2.5mils to 3.0mils for this die thickness. Physical die size can be estimated by subtracting half the saw kerf from each side of the die or by subtracting the entire saw kerf from the overall published dimension. Using a saw kerf of 2.5mils gives a typical physical die size of 31.5mils by 50.5mils (Figure 6).

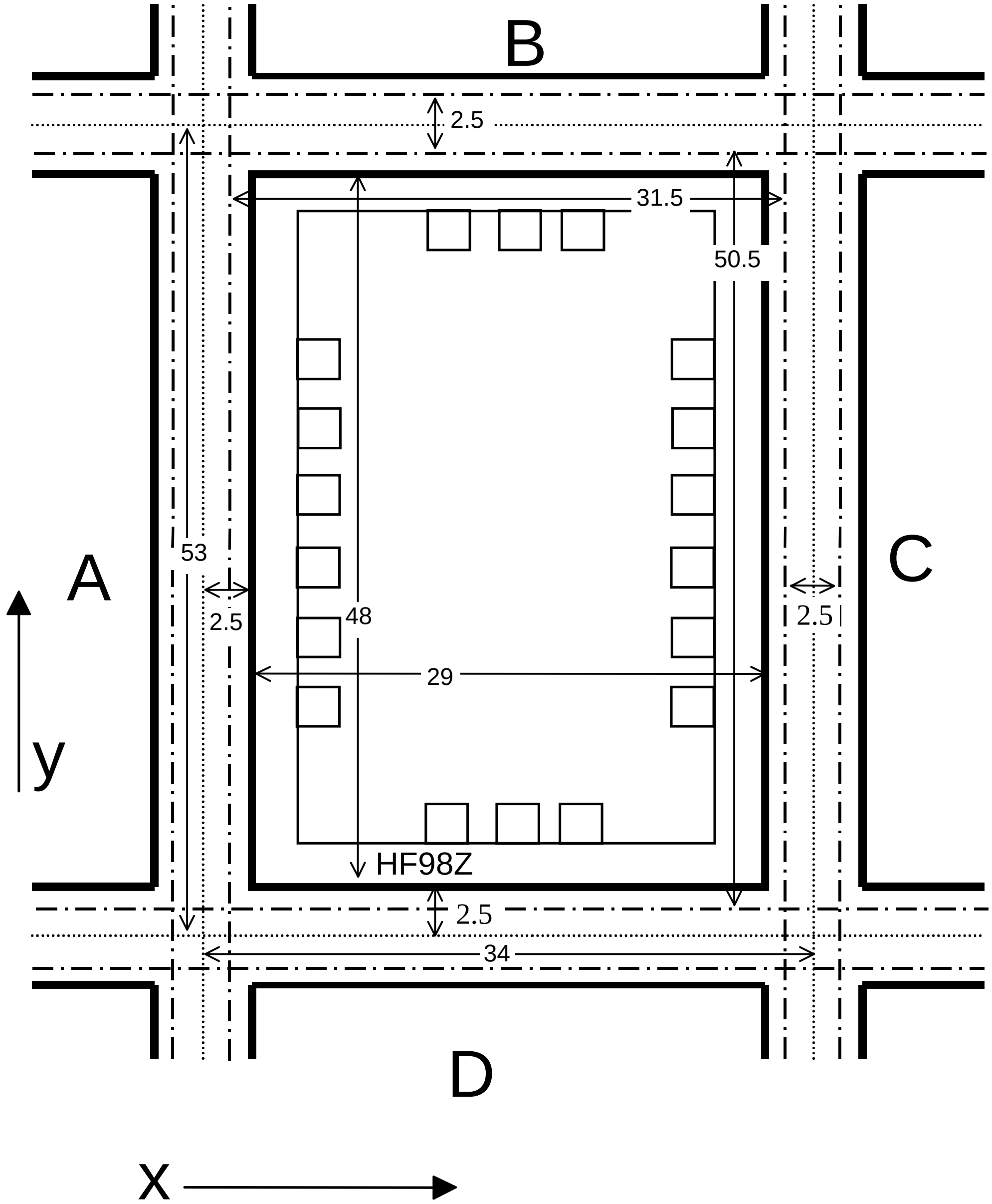

Figure 6. Measurements example

5 Conclusion

It is important to understand the difference between the physical die size and the published die size. The physical die size varies slightly due to manufacturing tolerances. For this reason, it is recommended that you use the referenced origin as described here for bond-wire placement. If a better approximation of the physical die size is needed, the methods and tolerances given will aid in calculating typical die sizes.